Chemistry and Application of Soft Porous Crystals from MOFs/PCPs

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Abstract

Metal-organic frameworks (MOFs) or porous coordination polymers (PCPs) possess inherent voids that allow the storage, delivery, and separation of substances, particularly gases. Among them, 3rd generation MOFs, called flexible MOFs or soft porous crystals (SPCs), exhibit a structural change from crystal to crystal in response to physical and crystalline stimuli. This feature distinguishes them from other porous materials, reminiscent of the induced fit mechanism of bioenzymes and the cooperative phenomenon of hemoglobin.[1] In contrast to rigid materials showing a Langmuir type I isotherm, SPCs possess a sigmoidal isotherm and higher usable capacity and efficient recognition of guest species. The flexibility depends not only on the binding ability and mobility of unit ligands and metal ions but also on other factors, including the deformation of the entire framework as a result of the guest molecules in the pores. Strategies using ligand functionalization have been developed to investigate the properties but have mainly focused on discovering and understanding SPC phenomena in SPCs. This trend has now shifted towards controlling the adsorption properties for practical applications. This talk provides an essential and accessible overview of the historical background of the chemistry of SPCs, their features, and outlook as 4th generation MOFs,[2,3] in particular, design and synthesis, dynamic structure analysis, flexibility and function, and theoretical treatment and interpretation of the mechanism, as well as their applications.

References

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Biography

Ph.D. in Engineering, Kyoto University. Kitagawa graduated from Kyoto University, served as Associate Professor at Kindai University, Professor at Tokyo Metropolitan University, Professor at Kyoto University in 1998, Director of iCeMS from 2013, and was appointed as Distinguished Professor at KUIAS in 2017. Kitagawa developed "porous" materials with numerous nano-sized holes. These materials are expected to be used to develop new materials to absorb carbon dioxide causing global warming and for medical applications. He was selected as a Thomson Reuters Citation Laureate in 2010 and Thomson Reuters / Clarivate Analytics Highly Cited Researcher in 2014 – 2020. He received the Medal with Purple Ribbon (The Japanese Government) in 2011, the Japan Academy Prize in 2016, the Chemistry for the Future Solvay Prize in 2017, and the Grand Prix of the Fondation de la Maison de la Chimie, France in 2018. He was elected as a member of the Japan Academy in 2019.